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Corrosion Control - Why the Laboratory Needs to be Involved

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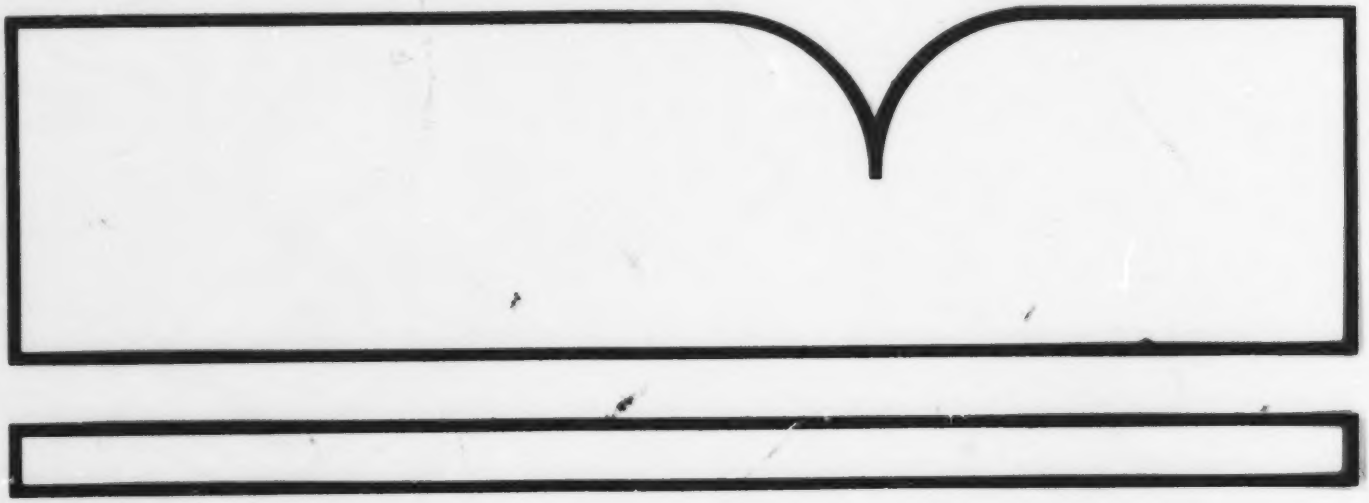

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16. ABSTRACT

The investment made in water distribution system piping and service lines and in building plumbing totals many billions of dollars. The decay and disintegration of America's public works facilities is a popular topic now. Although the situation may not be so drastic for water utilities as it is for roads and bridges, water utilities must not neglect their investment. Corrosion control can prolong the life of water mains and plumbing. The water utility laboratory has a key role in testing water quality to assess its corrosive nature, in evaluating pipes and plumbing for effects of corrosion, in testing corrosion control strategies for their efficacy, and in monitoring the dose of corrosion inhibitor applied to the water in a corrosion control program. The laboratory analyst is encouraged to recognize this role and to be active in promoting corrosion control.

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CORROSION CONTROL - WHY THE LABORATORY NEEDS TO BE INVOLVED

Gary S. Logsdon

Research Sanitary Engineer

Drinking Water Research Division
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

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Nashville, Tennessee,
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CORROSION CONTROL - WHY THE LABORATORY NEEDS TO BE INVOLVED

INTRODUCTION

The deteriorating condition of America's public works facilities was in the news this past summer. Newsweek, on the cover of its August 2 issue (1), proclaimed "The Decaying of America. Our Dams, Bridges, Roads And Water Systems Are Rapidly Falling Apart," and U.S. News & World Report featured ,"To Rebuild America - $2,500,000,000,000 Job" on the cover of the September 27 issue. (2) Neal R. Peirce, a syndicated columnist, devoted a column to "An $800 billion repair job for America." (3) These reports were based in part on America in Ruins (4), a publication of the Council of State Planning Agencies authored by Pat Choate and Susan Walter. Although all three titles suggest that public works facilities are seriously deteriorated, examination of the publication by Choate and Walter suggests that water utility facilities may be in better condition than other public works facilities, especially bridges and streets (Table 2, p 6 of Reference 4).

ECONOMIC CONSIDERATIONS

The grim implications of the above titles may not apply so much to water utilities as to other public works, but we should not be complacent. In 1976, LaNier (5) estimated that about 6 billion feet (1.2 million miles) of water transmission and distribution lines were in use. According to LaNier, 582 million linear feet of pipes were installed in the 1971-1975 time period. If we allow for installation at slightly over half that rate for 1976-1982, pipe in place at the end of 1982 should be about 6.4 billion feet or more. The pipe replacement cost would be a very large expenditure, on the order of one hundred

billion dollars, or more. In 1979 Edward Considine, Jr., reported in OpFlow (6) that water main replacement costs had averaged $18 per foot for Elmira, N.Y. in 1976. Choate and Walter (4) estimated that between $75 billion and $110 billion would be needed by the 756 urban areas with populations over 50,000 in the next two decades to maintain and upgrade their water systems. The investment in transmission and distribution systems is immense, and the replacement cost will be enormous.

Replacement may be inevitable, but in many cases the date when mains have to be replaced could be deferred if water utilities would implement a well conceived program for corrosion control. Water quality modifications will not solve problems caused by external corrosion, but the inner surface of unlined cast iron pipes, as well as valves, tanks and other appurtenances that convey or store water can last longer if corrosion control is practiced.

A good corrosion control program can also result in longer useful life for hot water heaters and building plumbing. Ryder (7) reported that residential plumbing systems incurred the major portion of corrosion-related costs in Seattle. The use of cement mortar lining, either factory-applied or applied on site to existing mains, has prevented corrosion problems in Seattle's steel, cast iron, and ductile iron transmission and distribution mains. Water quality modification is necessary, nevertheless, to protect copper and galvanized steel piping in buildings. Residential plumbing corrosion costs can be substantial, especially to the home owner who must make repairs or replacements. Installation of a new hot water heater may cost $200 to $300, replacement of accessible plumbing could cost $1000, and replacement of all household plumbing might require spending $2000 to $3000 or more. Ryder (7) estimated the annual savings for individual residences at $7.20 each, vs. an annual cost per residence of only

$1.40 for a corrosion control program, if such a program were adopted at Seattle. The value of corrosion control to water utility customers should not be overlooked when comparisons of costs and benefits are being made.

ROLE OF THE WATER QUALITY LABORATORY

The water quality laboratory can provide much of the data needed to learn whether the water supplied to the distribution system is corrosive. Analysis of tap water also may show the extent to which water quality in the distribution system is changing because of corrosion, and laboratory and pilot studies of corrosion inhibitors may suggest ways to remedy corrosion problems.

Analysis of raw water and of treated water entering the distribution system provides background information on the water quality. These data are often easily obtained, and may even be available from recent or ongoing monitoring efforts. Treated water quality data serve as the bench mark against which quality in the distribution system and household tap would be compared. Data on quality of treated water can also be used in computing corrosion indices to estimate whether the water might tend to be corrosive, but such indices must be applied with care. Some factors that cause or mitigate corrosion may not appear in the indices.

Analysis of water samples from various points in the distribution system and from taps of consumers can provide useful information on changes that occur in the water mains and in household plumbing. An increase in a corrosion product such as iron, copper, zinc, or lead should be a signal to the water utility chemist that a corrosion problem may exist. Water samples should be taken from various parts of the distribution system, including zones of high flow and dead end areas. Water from different types of distribution service connections, or household plumbing should be sampled. Water quality data should

be evaluated for relationships between water quality and the materials used in distribution mains, service lines, and plumbing. This may reveal the types of materials most likely to be corroding under present water quality conditions. Analyzing tap water samples for metals could also reveal whether corrosion of lead service lines or plumbing or of solders that contain lead may be causing violations of the Maximum Contaminant Limit for lead in drinking water.

If a more thorough program of evaluating corrosion is undertaken, the laboratory may become involved in preparation of coupons for corrosion tests and in evaluating exposed coupons. The laboratory also could conduct a program of examining pipe specimens taken from mains and plumbing that have been in service for many years. This work might include making observations of the quantity and nature of corrosion products that had built up on the pipe as well as cleaning the pipe and making observations on the extent and nature of pitting.

The laboratory has an important role in studies of water quality modification for corrosion control. Analysis before and after addition of corrosion inhibitors and pH adjustment chemicals will provide data on the dose needed to modify the water quality and on the physical and chemical environment in which the inhibitor is being used. This is important, because the efficacy of a corrosion inhibitor might be related to pH or some other water quality characteristic. After a period of exposure, materials that have been in contact with the modified water are examined to observe the extent of corrosion. Generally controls (materials exposed to unmodified water) would also be examined. The laboratory analyst may be called upon to report on the condition of the test coupons and to suggest which corrosion control additive was the most effective.

When a corrosion control strategy involving water quality modification is implemented, the laboratory will be expected to monitor the chemical feed process to be sure that the correct dose is being applied. Concentrations

of additive in the distribution system should be monitored for the duration of the additive program. After the water quality changes have been in effect for a period of weeks or months, analysis of distribution system and tap water samples can be done to provide a comparison of water quality before and after the corrosion control program. This will determine the capability of the control strategy to prevent corrosion related water quality degradation between the treatment plant and the consumer's tap.

SUMMARY

The laboratory analyst has an important role in corrosion control efforts. Reliable water quality data are needed by water utility managers who make decisions on the nature and extent of corrosion problems and on effective control strategies to reduce or eliminate the problems. Selection of a successful water treatment strategy for corrosion control can yield substantial savings by prolonging the service life of water mains, valves, tanks, service lines and plumbing. Armed with this realization, the water quality analyst should strive to obtain precise and accurate data that will facilitate selection of an effective approach to corrosion control.

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